Protocol for Recommending Issuance of a Fish Consumption Advisory
Due to Elevated Polybrominated Diphenyl Ethers (PBDEs)
Prepared by Dr. Luanne K. Williams, Toxicologist
North Carolina Department of Health and Human Services

Prevalence of PBDEs in Environment

Most toxicological studies concerning PBDEs have been conducted with commercial products containing deca-BDEs, nona-BDEs, and octa-BDEs (Pijnenburg AMCM, Everts JW, De Boer J, and Boon JP 1995 Polybrominated Biphenyl and Diphenylether Flame Retardants: Analysis, Toxicity, and Environmental Occurrence, *Reviews of Environmental Contamination and Toxicology*, Vol. 141). Some studies have reported a greater bioaccumulation of the PBDEs with a low bromine content (such as the tetra-BDE and penta-BDE) as compared to the higher brominated compounds (Pijnenburg AMCM, Everts JW, De Boer J, and Boon JP 1995 Polybrominated Biphenyl and Diphenylether Flame Retardants: Analysis, Toxicity, and Environmental Occurrence, *Reviews of Environmental Contamination and Toxicology*, Vol. 141; Sellstrom U, Jansson B, Nylund K, Odsjo T, Olsson M 1990 Anthropogenic brominated aromatics in the Swedish environment. Dioxin 1990 EPRI-Seminar. Bayreuth, Germany. Short papers, pp. 357-360).

Toxicity of PBDEs

The toxicity values for PBDEs were researched within the US EPA Integrated Risk Information System (on-line at http://www.epa.gov/iris). The following values and toxicity data were obtained.

PBDEs	**Reference Dose (dose not likely to result in noncancer health effects)**	**Carcinogenicity Data**
Pentabromodiphenyl ether	2 ug/kg-day (induction of liver enzymes in rats)	Class D (not classifiable because of no human or animal data)
Octabromodiphenyl ether	3 ug/kg-day (induction of liver enzymes in rats)	Class D (not classifiable because of no human or animal data)
Decabromodiphenyl ether	10 ug/kg-day (no adverse effects observed)	Class C (possible human carcinogen based on increased incidences of neoplastic liver nodules in rats and increased incidences of hepatocellular adenomas or carcinomas in mice)
Tetrabromodiphenyl ether	Not available	Class D (not classifiable because of no human or animal data)

PBDEs Action Level for Issuing a Limited Fish Consumption Advisory

Based on the review of the literature and the potential for the accumulation of the lower PBDEs, the 2 ug/kg-day reference dose for pentabromodiphenyl ether is the recommended toxicity value to be used in calculating the recommended monthly intake of PBDEs. It is reasonable to assume that a person would consume fish from multiple sources. Two to three additional meals per month or more may be obtained from areas other than the area of concern. Because of the uncertainty in the number of fish meals per month that will be consumed from other sources, the fish tissue level corresponding to a recommended 4 meals per month will be used in determining the action level for a limited consumption advisory. For instance, the action level for issuing a limited fish consumption advisory will be set at the fish tissue concentration that would equal to an acceptable 4 meals per month to allow for consumption from other sources. However, the recommended meals per month at this level will be 2 instead of 4 to allow for consumption from other sources. The following action levels were derived:

Step 1 –Expected Intake PBDEs per Meal

$$\frac{\text{Acceptable Intake per month (ug/kg-mos)}}{\text{Expected Intake PBDEs per meal (ug/kg-meal)}} = 4 \text{ meals per month}$$

Acceptable Intake per month = 2.0 ug/kg-d (accept. daily intake) x 30d/mos = 60 ug/kg-mos (ug/kg-mos)

Expected Intake per meal (ug/kg-meal) = x (unknown)

$$\frac{60 \text{ ug/kg-mos}}{\text{x (expected intake per meal ug/kg-meal)}} = 4 \text{ meals per month}$$

Expected intake per meal or x = 15 ug/kg-meal

Step 2 –Fish Tissue Concentration ug/gm corresponding to 15 ug/kg-meal

$$\frac{15 \text{ ug}}{\text{kg-meal}} \times \frac{\text{kg-meal}}{3 \text{ grams fish}} = 5 \text{ ug/gm}$$

Note: 3 grams fish/kg-meal is approximately 7 to 8 oz meal size for a 70 kg adult

When the average PBDE level is 5 ug/gm or 5,000 ug/kg or 5,000 ppb the following advisory may be issued: (Species) in (waterbody) contains higher than normal levels of PBDEs. Consumption of (species) should be limited to no more than two meals per person per month.

No Recommendations warranted at PBDEs less than 5000 ug/kg.

PBDEs Action Level for Issuing a No Fish Consumption Advisory

Based on the review of the literature and the potential for the accumulation of the lower PBDEs, the 2 ug/kg-day reference dose for pentabromodiphenyl ether is the recommended toxicity value to be used in calculating the recommended monthly intake of PBDEs. It is reasonable to assume that a person would consume fish from multiple sources. Two to three additional meals per month or more may be obtained from areas other than the area of concern. Because of the uncertainty in the number of fish meals per month that will be consumed from other sources, the fish tissue level corresponding to a recommended 2 meals per month will be used in determining the action level for a no consumption advisory. For instance, the action level for issuing a no fish consumption advisory will be set at the fish tissue concentration that would equal to an acceptable 2 meals per month to allow for consumption from other sources. The following action levels were derived:

Step 1 –Expected Intake PBDEs per Meal

$$\frac{\text{Acceptable Intake per month (ug/kg-mos)}}{\text{Expected Intake PBDEs per meal (ug/kg-meal)}} = 2 \text{ meals per month}$$

Acceptable Intake per month = 2.0 ug/kg-d (accept. daily intake) x 30d/mos = 60 ug/kg-mos (ug/kg-mos)

Expected Intake per meal (ug/kg-meal) = x (unknown)

60 ug/kg-mos = 2 meals per month
x (expected intake per meal ug/kg-meal)

Expected intake per meal or x = 30 ug/kg-meal

Step 2 –Fish Tissue Concentration ug/gm corresponding to 30 ug/kg-meal

30 ug x kg-meal = 10 ug/gm
kg-meal 3 grams fish

When the average PBDE level is 10 ug/gm or 10,000 ug/kg or 10,000 ppb the following advisory may be issued:
(Species) in (waterbody) contains higher than normal levels of PBDEs. No consumption of (species) is recommended.

Summary

Average PBDE Level (ppb)	**Recommendations to State Health Director**
<5,000 ppb	**No recommendations warranted –safe for unrestricted consumption**
5,000 pbb to < 10,000 ppb	**(Species) in (waterbody) contains higher than normal levels of PBDEs. Consumption of (species) should be limited to no more than two meals per person per month.**
10,000 ppb	**(Species) in (waterbody) contains higher than normal levels of PBDEs. No consumption of (species) is recommended.**